

April 30, 1857.

The LORD WROTTESLEY, President, in the Chair.

The following communication was read :—

“Inquiries into the Quantity of Air inspired throughout the Day and Night, and under the influence of Exercise, Food, Medicine, Temperature, &c.” By EDWARD SMITH, M.D., LL.B., L.R.C.P., Assist. Physician to the Hospital for Consumption and Diseases of the Chest, Brompton. Communicated by Dr. CARPENTER, F.R.S. Received March 19, 1857.

(Abstract.)

This communication consists of three parts, and contains the results of 1200 series of observations.

In the first part is contained the results of three investigations as to the quantity of air breathed during the whole of the 24 hours, and registered every 5, 15, and 30 minutes. The second part describes the influence of posture, various kinds of exercise, physical agents, and different articles of food and medicine, on the quantity of air breathed, and on the frequency of the respiration and pulse. The third part is devoted to certain inquiries in relation to the temperature of the body.

The author was himself the subject of all the investigations. He is thirty-eight years of age, six feet in height, healthy and strong, and with a vital capacity of the lungs of 280 cubic inches. The instrument employed was Glover's patent dry gas meter, of improved manufacture, and arranged to register from 1 to 1,000,000 cub. ins. Its action was reversed so as to measure inspiration. An ori-nasal mouth-piece was employed, and it was connected with the spirometer by vulcanized caoutchouc tubing, and could be fastened upon the head by elastic straps.

The determination of the quantity of air inspired in the 24 hours was effected by three inquiries. 1st, by using the spirometer whilst

in the quiet sitting posture during five minutes at the commencement of each quarter of an hour from 5 A.M. to 6½ P.M., and of each half-hour from 6½ P.M. to 3½ A.M. Exercise was taken in the intervals, and food was eaten at 8½ A.M., 1, 5½, and 8½ P.M. 2ndly, by using the spirometer without intermission during the whole of the 24 hours, except at intervals amounting collectively to 40 minutes. The posture, exercise, and periods of sleep were noticed and recorded, and the quantity of air inspired was read off at the end of every five minutes. 3rdly, by an inquiry similar to the second, but continued through the night only, from 6½ P.M. to 5½ A.M.; the quantity being recorded every quarter of an hour. The first inquiry was made on July 7 and 8, 1856, the second on January 19 and 20, 1857, and the third on January 21, 1857.

The maximum influence of various agents was determined both by the quantity of air inspired taken absolutely, and also relatively to that recorded immediately before the influence in question was exerted. The inquiries were made before breakfast, or at periods distant at least three hours from the last meal, so as to avoid the disturbing influence of food. Exertion, variation of posture, mental inquietude, change of temperature, &c., were avoided during the continuance of each inquiry, and hence the observations were never continued beyond a period of two hours. The quantity of air was determined during periods of five minutes at a time, twice during the first quarter of an hour, and once at the commencement of each succeeding quarter of an hour. The results were averaged per minute.

In all the above-mentioned inquiries the rate of respiration and pulsation and the temperature of the wet and dry bulbs with the barometric pressure were recorded.

The temperature of the breath was determined by the aid of an instrument consisting of a boxwood tube $\frac{3}{4}$ of an inch in diameter and 1½ inch in length, through the sides of which and at a right angle to it, a small thermometer was inserted and the bulb exposed freely to the exhaled breath. A valve was placed at the distal end which permitted the exit of the breath, but prevented the entrance of air, whilst near to the end which was placed between the lips when in use, a valve was fixed which moved in both directions. The bulb of the thermometer was thus enclosed in a small chamber.

The paper concludes with a summary of the principal results ob-

tained and a series of deductions, applicable especially to the solution or elucidation of hygienic questions. From the former the following facts are extracted :—

The total quantity of air inspired in 24 hours (allowance being made for intervals amounting altogether to 40 minutes, during which it was not recorded) was 711,060 cub. ins. ; or an average of 29,627 cub. ins. per hour and 493·6 per minute. The quantity was much less during the night than during the day. There was an increase as the morning advanced and a decrease at about 8^h 30' P.M., but most suddenly at about 11 P.M. During the day the quantity increased immediately after a meal, and then subsided before the next meal ; but in every instance it rose again immediately before a meal. The rate of frequency of respiration generally corresponded with the quantity, but the extremes of the day and night rates were greater. The period of greatest parallelism was between tea and supper. An increase was occasioned by one meal only, namely breakfast. The average depth of respiration was 26·5 cub. ins., with a minimum of 18·1 cub. ins. in the night, and a maximum of 32·2 cub. ins. at 1^h 30' P.M. The mean rate of the pulse was 76 per minute, the minimum at 3^h 30' A.M., the maximum at 8^h 45' A.M. ; the difference being more than one-third of the minimum rate.

Sleep came on in two of the series of continuous observations, and the time of its occurrence was also that of the lowest quantities of air inspired.

The amount of breathing was greater in the standing than in the sitting posture, and greater sitting than lying. It was increased by riding on horseback, according to the pace, also by riding in or upon an omnibus. In railway travelling the increase was greater in a second- than in a first-class carriage, and greatest in the third-class and on the engine. An increase was also produced by rowing, swimming, walking, running, carrying weights, ascending and descending steps, and the labour of the tread-wheel ; and in several of these cases the rate of increase was determined for different degrees of exertion used. Reading aloud and singing, and the movement recommended by Dr. Hall for restoring suspended respiration, increased the quantity ; bending forwards whilst sitting, lessened it.

The quantity of inspired air was increased by exposure to the heat and light of the sun, and lessened in darkness. Increase and decrease of artificial heat produced corresponding effects ; and the

depth of respiration was greatly increased by great heat. An increase in quantity was caused also by cold bathing, and sponging, and the cold shower-bath; by breakfast, dinner, and tea—when tea actually was taken, but when coffee was substituted there was a decrease. Supper of bread and milk also caused a decrease. Milk by itself or with suet caused an increase.

An increase was obtained with the following articles of diet, viz. eggs, beef-steak, jelly, white bread (home-made), oatmeal, potatoes, sugar, tea, rum (1 oz.). The following caused a decrease, viz. butter, fat of beef, olive oil, cod-liver oil, arrow-root, brandy (1 oz. to $1\frac{5}{4}$ oz.), and kirchenwasser. Ether ($\frac{1}{2}$ drachm) increased the quantity and depth of inspiration. A decrease in quantity was caused by sp. ammon. co. (3iss), sp. ammon. fet. (3iss), tincture of opium (20 M), morphia ($\frac{1}{6}$ and $\frac{1}{8}$ gr.), tartarized antimony ($\frac{1}{2}$ gr.), and chloride of sodium.

Carbonate of ammonia (15 grains) caused a small increase at first and then a small decrease; febrifuge medicines had a like effect. Chloroform (25 M and 3ss), by the stomach, varied the quantity from an average increase of 28 cub. ins. to an average decrease of 20 cub. ins. per minute; with a maximum increase of 63 cub. ins. per minute. Chloric ether (3ss) also varied the quantity, but there was an average increase of 17 cub. ins. per minute, and of 1·8 per minute, in the rate; whilst the pulse fell on the average 1·7 per min. Chloroform, by inhalation (to just short of unconsciousness), lowered the quantity a little during the inhalation, and more so afterwards. The rate was unchanged, but the pulse fell, on an average, 1·7 per min. Amylene similarly administered and to the same degree, increased the quantity during inhalation 60 cub. ins. per min., but afterwards decreased it to 100 cub. ins. per min. less than during the inhalation. The rate of respiration was unchanged: the pulse fell 6 per min. at the end of the observation.

Digitalis (infusion ʒi) varied the quantity, increasing it at first and then decreasing it. The rate of inspiration was unaffected, whilst that of pulsation somewhat increased.

The paper is accompanied by tables of numerical statements, and by diagrams exhibiting the results in a series of curves.

The President announced that the next Meeting of the Society, on the 7th of May, would be held in Burlington House.